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ABSTRACT

The Internet Web Site on Virtual Clinical Applications and Disease Management is a hypermedia, case-based open learning environment that was designed to promote cognitive flexibility in college students at The University of Georgia College of Pharmacy. With a key objective of pharmacy education being patient problem-solving skills, this environment exposes students to a variety of resources on the Internet that can be used in solving virtual patient case studies. Literature suggests that such environments promote complex knowledge structures in students with complex epistemic beliefs, but may cause students with simple epistemic beliefs to struggle. This paper describes cognitive flexibility and epistemic beliefs, and suggests that the combination of social constructivist approaches with cognitive flexibility hypermedia environments will promote learning for students with varying epistemic beliefs. The key benefit to using social mediation in cognitive flexibility hypermedia is in further scaffolding the complex, ill-defined knowledge structures found in these environments. If students rely on social structures too heavily, they may fail to develop flexible knowledge that arises from active engagement, personal struggles, trials, and errors with the complex environment. Any method providing students with answers rather than suggesting alternative means of addressing a given task should not be considered. (Contains 14 references.) (SWC)

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A Case-based Pharmacy Environment: Cognitive Flexibility + Social Constructivism

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Abstract: A hypermedia, case-based learning environment has been designed to promote cognitive flexibility in college Pharmacy students. Literature suggests such environments promote complex knowledge structures in students with complex epistemic beliefs, but may cause students with simple epistemic beliefs to struggle. This paper suggests and describes the combination of social constructivist approaches with a cognitive flexibility hypermedia environment to promote learning for students with varying epistemic beliefs.

Introduction

A hypermedia, case-based environment is being developed at The University of Georgia College of Pharmacy called the Internet Web Site on Virtual Clinical Applications and Disease Management. With a key objective of pharmacy education being patient problem-solving skills, this environment will expose students to a variety of resources on the Internet that can be used in solving virtual patient case studies. Resource links and case studies are being developed for this learning environment as World Wide Web pages. Students are provided with an on-line case then instructed to explore specific resources selected for that case as well as general resources which may or may not be related to the case. After building evidence and support for an accurate assessment of the problem state, students submit their assessment and treatment plan to the course instructor. Feedback is provided to the students once they have submitted their assessment in the form of a number of potential solutions to the case. For reference, (Jonassen, Ambruso & Olesen 1992) describe the Cognitive Flexibility Hypertext on Transfusion Medicine–a similar project utilizing cases, information in a variety of perspectives, and questioning of students to provide experience in diagnosing patients.

The Internet Web Site on Virtual Clinical Applications and Disease Management is an open learning environment designed with cognitive flexibility theory (CFT) in mind. While it has been shown that cognitive flexibility environments promote complex knowledge structuring in students with complex epistemic beliefs, there is evidence that students with simple epistemic beliefs may struggle with the same materials (Jacobson & Spiro 1995). This paper describes cognitive flexibility and epistemic beliefs, and suggests the combination of social constructivist approaches with CFT environments will promote learning for all students.

Cognitive Flexibility Theory

According to (Jacobson 1994), cognitive flexibility theory (CFT) asserts that students who develop "flexible representations of knowledge" will be able to adapt that knowledge to a wider variety of problem settings (p. 146). Cognitive flexibility theory supports the use of

hypermedia for learning and provides several design prescriptions for hypermedia that seek to promote flexible use of complex knowledge in students. Among these prescriptions are: using case studies to learn abstract concepts instead of learning facts that are removed from their context; presenting information from a variety of perspectives and representations; stressing the complexity of knowledge over the isolation and decontextualization of knowledge; stressing the network and relationships among knowledge; and involving the learner in the construction of new knowledge via problem-solving tasks rather than the recitation and memorization of facts, concepts, and principles (Jacobson & Spiro 1995).

When compared to traditional approaches that call for students to learn information apart from its context, materials designed according to cognitive flexibility theory (e.g., hyper-based cases) have been shown to promote transfer of complex knowledge to new settings (Jacobson & Spiro 1995). Transfer means students are able to apply new knowledge to a variety of problem settings more readily. Students exposed to CFT treatments, however, tend to perform worse on measures of factual memorization than colleagues who are exposed to more rigidly structured materials (Jacobson & Spiro 1995). These findings are not seen as disturbing if one takes the constructivist viewpoint that knowing how to learn and apply knowledge in multiple situations is more important than knowing or memorizing discrete and unstructured facts.

Epistemic Beliefs

(Jacobson & Spiro 1995) suggest students have different belief systems "related to the acquisition and structure of knowledge," and that these epistemic beliefs can "determine the type of cognitive resources the student accesses in performing learning and problem-solving tasks" (p. 305). The authors tested the hypothesis that students with complex epistemic beliefs who enjoyed active construction of knowledge via complex cases in multiple viewpoints and representations would be more successful with cognitive flexibility hypertexts (Jacobson & Spiro 1995). Students in an experimental condition receiving a cognitive flexibility hypertext treatment and who were tested to have complex epistemic knowledge averaged higher scores on a transfer-related, problem-solving essay task than students in the same treatment with less complex epistemic knowledge.

(Jacobson & Spiro 1995) point out "further research could collect data on the subjects' hypertext traversal patterns that could help clarify the relationship between epistemic beliefs, learning with hypertext, and knowledge transfer" (p. 327). When compared to their epistemic beliefs and scores on transfer measures, this information could determine whether cognitive flexibility theory is a valid approach for students with disparate epistemic beliefs. If students with simple epistemic beliefs are found to struggle with complex hypertext environments as seems to be the case, (Jacobson and Spiro 1995) suggest further research be conducted to "investigate how students with simple epistemic beliefs can be better prepared to use and learn from an instructional approach such as the Thematic Criss-Crossing Hypertext, which employs multiple knowledge representations and nonlinear linkages to demonstrate various knowledge component interrelationships" (p. 327). It is suggested here that the use of social constructivist techniques (e.g., instructor scaffolding, cooperative learning) might be one way to enhance the performance of students with simple epistemic beliefs in complex learning environments. As (Land & Hannafin 1996) suggest, "some learners meet the cognitive and metacognitive demands of open-ended learning; many others, however, do not." Combining elements of social constructivism with cognitive flexibility might prove beneficial for those learners unable to cope with complex processing.

Constructivism

Hypermedia based on cognitive flexibility theory fall under the constructivist psychological perspective. Constructivism calls for learners to actively participate in the shaping of their own knowledge structures rather than passively receiving facts and concepts. Differing perspectives on constructivism and student engagement exist ranging from mechanistic, exogenous views of dependent learners assimilating information given them (non-constructivism, or instructivism), to organismic, endogenous views of independent learners who seek information on their own and accommodate it with pre-existing knowledge into personally relevant constructs (Beed, Hawkins & Roller 1991; Moshman 1982; Prawat & Floden 1994).

Constructivism embodies authentic learning tasks, encourages student voice and ownership in the learning process, and suggests students be given experience at knowledge construction so that they will know how to learn, not just random facts. These principles are reflected in cognitive flexibility theory. Where CFT falls short of constructivism, according to (Jacobson 1994), is in the provision of social context and collaboration (p. 149). At the center of the constructivist continuum lies the social, dialectical constructivist movement where interactions between the student, instructor, and environment provide the foundation for learning (Moshman 1982). Popular social constructivist approaches include cognitive apprenticeships and modeling (Collins, Brown & Newman 1991), cooperative learning and reciprocal teaching (Brown & Palincsar 1989), and scaffolded instruction (Beed et al. 1991) in Vygotskian "zones of proximal development" (Vygotsky 1978). Considerable overlap between these methods exists with reciprocal teaching employing scaffolding, some cognitive apprenticeships employing reciprocal teaching, etc.

For cognitive flexibility theory to more closely match constructivist ideals, (Jacobson 1994) suggests combining social constructivist approaches with CFT as a sort of "theoretical pluralism" that will better inform the design of learning environments (p. 149). One popular social constructivist approach is the cognitive apprenticeship model. Cognitive apprenticeships stress the following principles: teach metacognitive skills as well as content information; situate content in an authentic environment; model, demonstrate, and explain processes; coach students by providing hints, prompts, and guidance as needed; encourage students to think aloud and articulate why they are making certain decisions; encourage students to reflect on their performance; allow students to explore and test a variety of hypotheses; and sequence content with an increasing level of difficulty but with a global, big picture idea of the problem state from the start (Wilson & Cole 1991). Table 1 illustrates the areas in which cognitive flexibility theory falls short of the cognitive apprenticeship model and how incorporating elements of social constructivism and collaboration afford a more complete approach to the design of truly constructivistic hypermedia environments.

Cognitive Apprenticeship Ideals	How Well Cognitive Flexibility Matches Up	Socially-Mediated Affordances
1. teach skills	promotes transfer of knowledge in students rather than rote memorization	
2. situate	authentic learning contexts, cases	
3. model	can be built into the hyper materials, but typically this is not socially mediated	instructor can demonstrate proper techniques and interact with students
4. coach	system-based feedback to student input, but not very adaptive or intelligent	instructor can adapt to student difficulties, providing helpful hints and guidance
5. articulate	with proper tools, students can be encouraged to write reports or provide data to the instructor	students can communicate and discuss content with colleagues and the instructor
6. reflect	system can suggest students reflect, but typically this is not socially mediated	collaboratively, students can share opinions with others and from differing viewpoints begin to see errors in judgment, developing more flexible knowledge
7. explore	hypermedia and provision of links and rich cases encourages students to explore	
8. sequence	cognitive flexibility materials typically structured as complex cases, not segmented chunks	cooperative learning and communication can enable students to share ideas & collectively tackle the complex problem state

Table 1: Affordances of social mediation in cognitive flexibility hypermedia.

To date, only a limited number of hypermedia environments have bothered to integrate social constructivist ideals and collaborative activities into the overall design. This is in spite of the fact that many hypermedia applications now found on the Internet could benefit from an increasing array of communications options such as groupware, listservs, electronic mail, and live audio-video connections.

The key benefit to using social mediation in cognitive flexibility hypermedia is in further scaffolding the complex, ill-defined knowledge structures found in these environments. As (Beed et al. 1991) describe, there are five levels of instructor scaffolding: (e) teacher models behavior or response; (d) teacher encourages students to participate; (c) teacher directs student attention and provides hints about specific elements of strategies they could employ; (b) teacher names strategies and encourages students to use them; and (a) teacher asks general questions such as, "what might you do at this point...." Responsibility for choosing appropriate strategies and engaging the task is eventually faded from the instructor to the student. The level of instructor scaffolding lies on a continuum, then, from total teacher modeling of the desired behavior or response to eventual fading of help and complete withdrawal of all support.

Suggestions For Combining Social Structure With Cognitive Flexibility

As the Internet Web Site on Virtual Clinical Applications is being developed, plans are being made to incorporate elements of social structure that will support students with varying epistemic beliefs. A number of approaches can be taken toward combining social structure with complex hypermedia environments.

First, one can simply ignore the fact that students with different epistemic beliefs will have varying success with complex hyper environments. This approach is ill-advised based on cognitive flexibility research (Jacobson and Spiro 1995) that has shown individuals possessing complex epistemic beliefs will tend to access a larger number of remote sources to solve a case and access those files in a more random, haphazard fashion than individuals possessing simple epistemic beliefs. Conversely, those with simple epistemic beliefs will be more likely to rely on one or two resources in making potentially unfounded assumptions and assessment plans.

A more formal approach to minimizing these effects (particularly if research is of interest) is to employ assessment procedures to help classify students by their beliefs. This evaluation will provide some indicator of ability to succeed in the open-ended environment. (Jacobson and Spiro 1995) describe an instrument they used to measure epistemic beliefs (p. 317). Further, (Kitchener & King 1994) have developed and validated the related reflective judgment assessment to classify students on a number of critical thinking levels. Using these assessments, it would be possible to group students with varying beliefs about knowledge with the assumption that more naive students would benefit from a pairing with students possessing complex epistemic beliefs. The impact of heterogeneous social grouping in a hypermedia environment was investigated by (Repman, Weller & Lan 1993) who discovered lower ability students may benefit from such a pairing, but with unclear effects on the higher ability students.

Despite unclear effects of grouping by ability level, cooperative learning still seems to have merit in scaffolding complex environments. (Repman et al. 1993) suggest students working in groups go through a variety of processes such as "mutual guidance" and "disagreement over conclusions and tactics" (p. 286) which help them move to higher levels in the zone of proximal development--the cognitive processing and problem solving area from just within to just outside of a student's ability level (Vygotsky 1978). (Brown & Palinscar 1989) discuss literature indicating cooperative settings can improve learner outcomes. As students converse and verbalize their interpretation and resolution of problems, they are elaborating on and extending their understanding of the complex topic. Course instructors using the Internet Web Site on Virtual Clinical Applications and Disease Management are considering the formation of small groups toward cooperative problem-solving.

The provision of scaffolding is yet another method of incorporating social structure into a complex hypermedia environment. This is one approach taken by the Internet Web Site on Virtual Clinical Applications and Disease Management. A closed listserv used by students and instructors will be a critical part of the environment as a forum for questions and communication. The instructor, through responses and promptive listserv postings, will be able to scaffold student problem solving approaches to the case studies. Scaffolding requires that instructors know about strategies and techniques used in specific settings which can be applied to tasks and used to solve problems. Instructors, then, are able to cue and prompt students in the appropriate use of helpful methods and approaches as they struggle to learn confusing material at the high end of their zone of proximal development (Vygotsky 1978). Students faced with a complex problem-solving task might benefit from a scaffolded presentation of reflective judgment (Kitchener & King 1994) and problem-solving models. As (Pressley, Harris & Marks 1992) point out, the appropriate use of strategies in the classroom involves "students and teachers collaborating to work out an understanding of the strategies

and how to use them effectively, rather than the teacher providing canned, standardized input" (p. 10). Students should be shown up front that problem solving by nature is confusing and vague. This direct presentation would give them more confidence to try out a variety of potential solution paths without feeling like they were wandering haphazardly through the hyper environment.

Future Questions To Consider

While it seems obvious that the combination of social supports into a complex environment will benefit students, several cautions are warranted. For instance, the use of cooperative learning might benefit students with simple epistemic beliefs, but what effect will the approach have on students with complex beliefs who were previously successful in such environments? Further, will the use of social supports undermine the development of complex knowledge structuring in students? If students rely on social structures too heavily, they may fail to develop flexible knowledge that arises from active engagement, personal struggles, trials and errors, etc., with the complex environment. In this light, perhaps the only social approaches that should be considered are those that scaffold student struggles (e.g., strategy instruction). Certainly any method providing students with answers rather than suggesting alternative means of addressing a given task should be immediately thrown out of consideration. Further research is called for in these areas.

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